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Analytical and numerical ray tracing of x-ray lasers

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Soft x-ray lasers in 10-30nm range are now routinely produced in hot plasmas generated either by a laser from a solid target or by an electrical discharge in a capillary. Such an x-ray laser is a convenient tool for future applications, such as probing dense plasmas of interest for fusion experiments. Their short wavelength enables plasma diagnosis beyond the capabilities of optical lasers, because the high critical plasma density ($\sim\lambda^2$) limits the optical beam propagation. In our paper, we present analytical and numerical ray tracing of an x-ray laser in dense amplifying plasmas. A general analytical formula for a beam propagation has been developed for a gradient plasma. The simplified analytical formulaes enable better understanding of processes involved. They also simplify optimization of the beam propagation and "mapping" the parameter space for further studies by numerical codes. We discuss implications for a transient x-ray laser that is produced from a slab target by a (sub-)picosecond laser pulse.

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